FOOD FORTIFICATION AS AN EFFECTIVE TOOL FOR THE BETTER NUTRITION: AN EXPERIENCE FROM COMMUNITY-BASED FLOUR FORTIFICATION PROGRAM IN INDIA

A Project Paper

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Master of Professional Studies in Agriculture and Life Sciences

Field of International Development

by

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August 2019

ABSTRACT

A global burden of micronutrient deficiencies often referred as ‘hidden hunger’ is a major public health challenge affecting 821 million people worldwide. This paper discusses the global experience of food fortification as a feasible and cost effective method to reduce the micronutrient deficiencies, alongwith other approaches like balanced diet and supplementation. It further discusses the interventions of the **S**ustainable **F**lo**u**r Fo**rt**ification **I**nitiative (SFurtI) in reducing the micronutrient malnutrition through the network of women’s self help groups in Gujarat, India. The program is reviewed on the basis of the multi-dimensional framework for nutrition originally proposed by the UNICEF. The paper discusses in detail about the role of the program in supporting the household food access and individual nutrition through the four quadrants of the framework - household income, household access to diverse food, positive nutrition behavior and nutrient absorption.

BIOGRAPHICAL SKETCH

Kasim holds a Master's in Business Administration degree from ICFAI University, Dehradun, India and has experience working in the areas of agriculture and nutrition with special focus on food fortification.

Dedicated to all members of SFurtI *parivaar*.

ACKNOWLEDGMENTS

I would like to thank Professor Prabhu Pingali for his constant support and valuable guidance throughout my program to help me successfully complete this research work. I would also like to thank Professor James Lassoie and Professor Terry Tucker for their support and encouragement.

Lastly, I would like to thank Dr. Bhaskar Mittra and the Tata-Cornell Institute for giving me an opportunity to work in the Sustainable Flour Fortification Initiative (SFurtI). Due to this valuable experience, I could write this paper.

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- SFurtI: Sustainable FloUrfoRTification Initiative
- ICDS: Integrated Child Development Services
- MDM: Mid-Day Meal
- PDS: Public Distribution System
- WFP: World Food Program
- UNICEF: United Nations Children's Fund

CHAPTER 1

INTRODUCTION

With the advent of Green Revolution, the world started tackling an issue of food security more efficiently. As a result of Green Revolution, most nations turned their agricultural fortunes from being frequently drought hit, food insecure, to self-sufficient food producers and some cases even exporters (Spielman & Pandya-Lorch, 2009). Much of the success can be attributed to the combination of high rates of investment in crop research, infrastructure, and market development and appropriate policy support that took place during the Green Revolution (P. L. Pingali, 2012). The worldwide agricultural research and development during that period showed a great level of integration and cooperation. Governments of many developing and developed nations applied and further refined these research outcomes to customize it according to their needs. Unfortunately, these researches were limited to few crops like rice, wheat and maize. Though it made the world better equipped to handle the food security by providing enough calories, it compromised the nutritional aspect of the diet by focusing more on the staple food. Policies like fertilizer and credit subsidies, and price supports promoted staple crop production, led to displace the production of traditional non-staple crops that were important sources of critical micronutrients (P. Pingali, 2015). A slow-paced development in the food industry made the situation not any better.

An emphasis over calories is still present and while this passion isn't needless it often understates the importance of micro-nutrients – which are critical to bodily functions (P. L. Pingali, 2012). This has been acknowledged in UN's Sustainable Development Goals (SDGs). Hence SDG 2, in

addition to ending hunger and achieving food security, also emphasizes on improved nutrition. The target is to end all forms of malnutrition by 2030, including the internationally agreed targets on stunting and wasting in children under 5 years of age, by 2025, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons (High-Level Political Forum, SDKP, 2017).

A global burden of micronutrient malnutrition

Malnutrition is generally categorized into two types. One is Protein Energy malnutrition caused due to deficiency of proteins and calories. The other is Micronutrient malnutrition is caused due to deficiency of micronutrients like vitamin A, vitamin B complex, iodine, iron, calcium, zinc, selenium, etc. As per the Food and Agriculture Organization (FAO), the number of malnourished people in the world has been increasing since 2014, reaching an estimated 821 million in 2017. It means 10.9 percent people globally are undernourished. One in every three women of the world of reproductive age group is anemic, with a substantial health and developmental threats for both women and their newborns. In 2017, 50.5 million (7.5 percent) children under 5 years of age were suffering from wasting (low weight for height) subsequently putting them at a higher risk of death. An analysis from 2013 showed that 12.6 percent of all deaths among children under 5 years of age were associated to wasting, of which 7.4 percent were related to severe wasting.

As per the National Nutrition Monitoring Bureau report (NNMB 2011-12), the median intakes of all the major micronutrients were below the RDAs for Indians. The percentage of preschool children with less than 50% of the RDA for calcium, iron, vitamin A, riboflavin, and vitamin C was about 51-82%, whereas the same for adolescents was 52–85%. The intakes of micronutrients,

such as iron, vitamin A, riboflavin, vitamin C, and folic acid, were below 50% of the RDA in 51–83% of pregnant women. There is increasing documentation to show that micronutrients deficiencies are responsible for causing severe damage to health of the population.

Micronutrient malnutrition, also referred as "hidden hunger", can have serious repercussions including learning disabilities, weakened work capacity and illness, eventually leading to death. Though micronutrients are required in very small amounts, these are necessary for effective metabolic activities and for functions such as growth, cognition, immune system and reproduction. Hence it is central to address micronutrient malnutrition from the early childhood to reduce lasting effects on growth and development. The proportion of undernourished people is increasing affecting 815 million people worldwide (*SDG Report*, 2018). Many of these numbers are coming from the developing world, where population is suffering from one or more micronutrient deficiencies, mostly iron, iodine, vitamin A, folic acid or zinc (Mason et al., n.d.). The importance of micronutrients in the health and well-being is proved by the fact that iron, zinc and vitamin A deficiencies are amongst the main risk factors of the global burden of disease (World Health Organization, 2018). Micronutrient deficiency is affecting the population worldwide resulting into 35 percent of people with inadequate iodine, 40 percent with iron deficiency, and more than 40 percent of children are vitamin A deficient (Mason et al., n.d.)

Complementary strategies to overcome the micronutrient malnutrition

As a result of the World Summit for Children, New York, 1990, Ending Hidden Hunger Conference (1991) and International Conference on Nutrition (Rome, 1992), many developing countries focused to address an issue of micronutrient deficiencies. The awareness on the micronutrient malnutrition has substantially increased in the past few decades.

One of the approaches to combat micronutrient malnutrition is a supplementation. It is a more focused short-term approach to address severe deficiency situations. It involves administering regular doses of the micronutrient in a concentrated supplement form to combat the severe deficiency. An example of it is the National Iron+ Initiative, launched by the Adolescent Division of the Ministry of Health and Family Welfare, Government of India. In this program, the priority groups like children, pregnant and lactating mothers are being administered for supplementation of iron pills through institutions like schools and nutrition care centers (See table 1).

Table 1: IFA supplementation program and service delivery

Age group	**Intervention/Dose**	**Regime**	**Service delivery**
6-60 months	1 ml of IFA syrup containing 20 mg of elemental iron and 100 mcg of folic acid	Biweekly throughout the period 6-60 months of age and de-worming for children 12 months and above	Inclusion in MCP card through ASHA/ANM
5-10 years	Tablets of 45 mg elemental iron and 400 mcg of folic acid	Weekly throughout the period 5-10 years of age and biannual de-worming	In school through teachers and for out-of-school children through Anganwadi center (AWC)
10-19 years	100 mg of elemental iron and 500 mcg of folic acid	Weekly throughout the period 10-19 years of age and biannual de-worming	In school through teachers and for those out-of-school through AWC

Pregnant and lactating women	100 mg elemental iron and 500 mcg of folic acid	1 tablet daily for 100 days, starting after the first trimester, at 14-16 weeks of gestation. To be repeated for 100 days	ANC/ANM/ASHA Inclusion in MCP card
Women in reproductive age group	100 mg elemental iron and 500 mcg of folic acid	Weekly throughout the reproductive period	Through FHW during house visit for contraceptive distribution

The success of supplementation programs depends on many factors. Some of these are - the long-term commitment of the implementing institution, efficient supply chain mechanism, well trained service providers, degree of awareness among the beneficiaries, strong monitoring and evaluation, rapid response mechanism in the event of any adverse effects.

Dietary diversification is a long-term approach to ensure sustained outcome. It involves ensuring access and encouraging population to consume foods rich in micronutrients including fruits and vegetables. Though it is the best approach to reduce micronutrient malnutrition, accessibility and availability of the balanced diet[1] is a major challenge especially in the developing world where the micronutrient deficiency is the biggest public health problem.

Food fortification is the practice of adding essential vitamins and minerals (e.g. iron, vitamin A, folic acid, iodine) to staple foods to improve their nutritional content. Fortification is a safe and effective way to improve public health that has been used around the world since the 1920s. Commonly fortified foods include staple products such as salt, maize flour, wheat flour, sugar,

[1] Balanced diet should have one source of calories, one source of protein, very high intake of fresh vegetables, and adequate intake of fresh whole seasonal fruits and adequate water (2–2.5 L per day or water enough to produce at least 1.5 L of urine output).

vegetable oil, and rice. Food fortification is commonly recognized by many populations and international and regional health organizations.

CHAPTER 2

FOOD FORTIFICATION AS A STRATEGY

The FAO has defined fortification as the process of addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups. The food in which the nutrients are added is called 'vehicle' for fortification and the nutrients to be added are called as 'fortificants'. There is a range of vehicles like milk, salt, cereal grains, sugar, etc. to accommodate variety of fortificants like iron, vitamin A, folic acid, iodine, etc. Fortification is the most cost effective and efficient method to cater large population with essential micronutrients. It can be regarded as the best food-based method for solving the micronutrient deficiencies in developing world.

Global experience with food fortification

Food fortification has a long history of being used successfully to overcome nutritional deficiencies that were having adverse effects on public health. In 1920s, medical researchers found that iodine could prevent goiter, which was prevalent during that period. Fortification of salt with iodine was demonstrated as an effective method in reducing goiter outbreak by 74–90% in many regions of the world. This success formed a path for future interventions in fortification of foods. During the period of 1924 to 1944, iodine was mixed with salt, vitamins A and D with margarine, vitamin D with milk, and vitamins B1, B2, niacin and iron with flour and bread. During World War II, both the United Kingdom and the United States governments endorsed voluntary

fortification of flour and bread. In the UK, fortificants like calcium, thiamine, niacin and iron were added to the processed food like bread to prevent nutritional deficiencies. Current interventions are focusing on the upgradation of cereal grain-based foods with folate since many studies bolstered the role of fortification in reduction of the prevalence of neural tube birth defects by 25% (Raloff, 2014).

Food fortification experience from developed countries

During 1930s, USA approved fortification of flour and bread with niacin followed by iron. Flour fortification has been helpful in reducing number of deaths due to pellagra, an illness caused due to niacin deficiency (Mertz, 1997). The regular consumption of fortified foods is associated with the low levels of iron deficiency in the USA. Canada began fortification of flour with vitamin B in 1944. Vitamin B deficiencies decreased from 20% to insignificant levels within a period of 4 years. The compulsory folic acid fortification of cereal-grain products post 1998 in the USA, Canada and Chile has led to 30 to 70% drop in number of newborns with neural tube defects. Studies show that even the voluntary fortification of cereal foods has contributed to improve the micronutrient status in the countries like France, Ireland, the United Kingdom and Spain (*New and Noteworthy in Nutrition (NNN)*, 2003). The experiences from these countries advocates that with the well-developed food industry following effective quality assurance procedures and where processed foods are commonly consumed, fortification has proved to be an effective tool in reducing micronutrient malnutrition.

Table 2: Food fortification initiatives by developed countries

Starting year	Country	Nutrients/vehicles	Deficiency disorder to be controlled
19th and 20th century	France/USA	Iodine in salt	Cretinism, mental retardation)
1918	USA	Vitamin D in milk	Rickets
1940s	USA	Iron and B vitamins in wheat flour	Beri-beri, Pellagra
1980s	USA	Calcium in flour, dairy products and other foods	Osteoporosis
1998	USA	Folic acid in wheat flour	Neural tube defects

Food fortification experience from developing countries

Developing countries are also seeing a progress in fortifying many food items during past three decades. The fortification of salt with iodine demonstrated huge success saving millions of newborns each year from the risk of mental impairment and other sub-clinical deficiency syndromes. As per the Global Fortification Data Exchange for the period of 2000 to 2018, there is a growth in fortification of flour, oils, sugar, condiments, dairy products and many processed foods with micronutrients. A fortification program started in Venezuela in 1993 in which fortification of precooked corn flour with iron (50 mg), vitamin A (9500 IU), thiamine (3.1 mg), niacin (51 mg) and riboflavin (2.5 mg) per kilogram is a successful initiative. It helped in reduction of iron deficiency in school children from 37% to 16% in two years of implementation (Layrisse et al., 1996). As of now about nineteen countries in Latin America and Caribbean have a national food fortification program for iron and other micronutrients in wheat and/or corn flour (Global Fortification Data exchange, 2018).

Many countries from the Middle East and North Africa started fortification with iron and folic acid to cereal flour. Prior to 1998 only Saudi Arabia was fortifying flour, by 2018 a total of 39 countries in the region produced and consumed fortified flour containing at least iron and folic acid (in some cases vitamin A and other B complex vitamins also) on a national or state level. There is more focus on wheat flour fortification in Asia. National level flour fortification programs are being implemented in Indonesia, Philippines, Pakistan and Nepal while many states in India have incorporated fortification under their food and nutrition programs.

The global experiences demonstrated the importance of the selection of a country specific food vehicle which is being consumed by majority of the population. For example, selection of soy and fish sauces as a food vehicle for fortification in China, Vietnam and Thailand is the best approach as more than 80% of the population consumes these sauces regularly with a network of government supervised sauce factories. Worldwide consumption of salt makes it standard choice for fortification with iodine.

The World Food Program (WFP) which is responsible for delivering food to displaced populations and in emergency situations is distributing fortified foods procured from industrialized countries since many decades. The WFP has started fortifying and milling of locally produced grains. It is producing fortified foods in 13 of the world's under-developed nations including Nepal, Madagascar, Ethiopia and Malawi.

Food fortification has eliminated many nutritional deficiencies of the populations in many countries in the world over the last century. Currently, 137 countries have compulsory fortification while several other countries exercise voluntary food fortification. The global experiences led the changes in the approach and the technology of food fortification involving careful selection of suitable food vehicle and fortificants, stages of fortification, safety, feasibility and sensory tolerance, bioavailability, storage and stability, methods of blending, efficacy and, the cost.

CHAPTER 3

FOOD FORTIFICATION IN INDIA

Initially, the fortification initiatives in India were focused on improving the protein and energy consumption. This approach slowly incorporated the food fortification with micronutrients. A National Nutrition Policy of 1993 was introduced to operationalize multisectoral strategies for addressing the public health problem of malnutrition. Later on, the National Plan of Action on Nutrition was released by Government of India in 1995. It recommended an integrated approach such as promotion of dietary diversification, nutrient supplementation and food fortification (*National Plan of Action on nutrition -1995*). The Department of Women and Child Development, Ministry of Human Resource Development, India along with the United Nations World Food Program in 2000, came up with a white paper on prevention of micronutrient malnutrition through Integrated Child Development Services (ICDS).

Government of India has accepted food fortification as an important and an effective food-based approach to combat micronutrient deficiencies and it is working on it since many decades. Modern Bakeries, a public sector organization of the Government of India started the distribution of fortified bread with lysine, vitamins and minerals. It substantially improved the weight and height of children. Iron fortified salt was tested by the Food and Nutrition Board of the Government of India in alliance with the National Institute of Nutrition (NIN). The parameters like bio-availability, storage, and utilization of iron in Indian cookery practices were studied (Rao & Vijayasarathy, 1975). Iron fortified sugar and tea was also tested.

Many processed foods including complementary feeding foods are currently being fortified with vitamins, calcium, and iron, as per the guidelines of Food Safety and Standards Authority of India (FSSAI). Hydrogenated vegetable fat – referred as *vanaspati* in India, is mandatory to be fortified with 25 International unit (IU) of vitamin A per gram (4% RDA). But there is significant decrease in consumption of *vanaspati* in the past three decades making it a less effective vehicle for fortification in India.

India is a big market for the products like fortified breakfast cereals, noodles, milk, edible oils, fruit juices, breads, biscuits etc. However, most of these products cannot be afforded by the poor and undernourished population. The need for developing fortified products which are affordable, acceptable, scalable and sustainable is being recognized.

Food fortification through public welfare programs

In India, several public safety net programs such as the Integrated Child Development Services (ICDS), Mid-Day Meal (MDM) and Targeted Public Distribution System (TPDS) provide supplementary food to various priority households.

Food fortification through ICDS program

ICDS has a life cycle approach of targeting children 6 months to 6 years of age, as well as adolescent girls and pregnant and lactating mothers. The Ministry of Human Resource Development, Department of Women and Child Development, Government of India wide their circular No. 5-17/2004-ND/Tech.FF dt. 12 July 2005, issued a notification to all the State

Governments to fortify the supplementary nutrition component with multiple micronutrients providing 50% of RDA of selected nutrients to the children and women beneficiaries.

In West Bengal, a fortified food distribution program was launched through ICDS. A traditionally distributed food item like Khichdi (rice, lentils and oil mixture cooked to a soft semi-solid consistency), is fortified with a multiple micronutrient premix "vita shakti" which supplies 500 IU of vitamin A, 14mg of microencapsulated iron (ferrous fumarate) and 0.05mg folic acid per day. Initially in 2006, fortified food reached 4.8 million beneficiaries. later it was scaled up by the State Government at their own cost (additional cost of fortification being Rs.9/- per annum) in the year 2006-07. The findings from this program discovered that the strategy was feasible and the product was acceptable from the indication of the high program compliance by both ICDS workers who prepared the fortified Khichdi and by the enrolled children, who consumed it.

Fortification of Ready to Eat (RTE) food for ICDS has been reported to be cost-effective strategy. Centralized production of RTE supplementary food using wheat and chick-pea flour reached 0.35 million beneficiaries in four districts of Gujarat State was fortified with 50% of RDA levels of iron, vitamin A and folic acid. The impact assessment on the nutritional status of the beneficiaries consuming fortified RTE food showed a substantial drop in the incidence of micronutrient deficiencies.

Food fortification through MDM program

Mid-Day Meal (MDM) program is focusing on a cooked food supplementation provided to school children five days a week, with a detailed menu for each day of the week. Meal prepared from rice

/ wheat, vegetable / dal provides 450 calories and 12 grams of protein per day. Many states promoted fortified food through this program. In Uttarakhand, a multiple micronutrient premix "Sampoorna" having 14 different micronutrients developed by WFP was used to fortify the MDM in all the schools in Tehri district. The premix was added at the rate of 0.25 g per child per day. The study showed that the fortified MDM was effective in improving vitamin A, folate, iron and vitamin B12 status of school children. Currently, the program has a pan India presence where many states are promoting fortified foods for achieving better nutrition outcomes for the beneficiaries.

Food fortification through PDS

In its 10th Five Year Plan document, the Planning Commission of India has recommended food fortification as an important strategy for prevention and control of micronutrient malnutrition with special reference of iron fortification of wheat flour (*10th_vol2*, 2002). A trial was implemented to study the operational feasibility of fortified wheat flour in improving the iron and vitamin A status of the population in West Bengal. The government provided 200 gms of fortified flour person/day to about 0.6 million below poverty line beneficiaries under the Targeted Public Distribution System for four priority groups like pregnant and lactating women, pre-school children, school age children and adolescent girls in the population. An impact study after 2 years of implementation showed a substantial decrease in anemia prevalence in all the target groups. The program was scaled up in the entire state of West Bengal since the results were positive.

After West Bengal, many states like Andhra Pradesh and Gujarat started supply of fortified wheat flour through PDS. The Roller Flour Millers' Association of Gujarat launched fortified flour in open market (Fiedler, Babu, Smitz, Lividini, & Bermudez, 2012). Gujarat state has extended the

reach of fortified food by involving government programs such as the PDS, ICDS and the MDM programs.

The flour fortification program has started in many Indian states including the Union Territory of Chandigarh, State of Tamilnadu, Kerala, Haryana, Punjab and many more. These states are recognizing the potential of fortification with approaches like voluntary or mandatory fortification of staple food at state level. The India Flour Fortification Network (IFFN) has been created involving all stakeholders to integrate and support the flour fortification programs in the country.

The major takeaway from the India's wheat fortification progress is that the government support and commitment is an important factor for a sustainable fortification program. This support should be in the form of political will, lending a government logo, providing support for awareness generation and demand creation, and monitoring the program. In 2016, FSSAI has revised its guidelines for fortification followed by the recommendations from many national and international expert agencies and launched a logo for fortified foods for public awareness.

Figure 1: FSSAI fortification logo

CHAPTER 4

FLOUR AS A PROMISING CHANNEL FOR FORTIFICATION

Fortification has more benefits over other methods as it does not require modification in dietary behavior of the population, provides a substantial amount of the recommended dietary allowances for many micronutrients on a regular basis and does not require individual compliance. It is more sustainable as it can be incorporated into the current food production and distribution system. The important considerations in food fortification comprise choice of suitable food vehicles that are consumed by most of the population. It is also important to ensure stability, appearance, bioavailability and consistency. The selection of food vehicle depends on local availability and consumption patterns and can be crucial in getting desired results.

With 1.3 billion people, India is the 2nd most populated country in the world. India is a home of 200 million undernourished people (fao.org, 2018). Mandatory fortification of salt with iodine helped India in significant reduction in goiter. Double fortification of salt with iodine and iron since mid-2000s yet to gear up at pan India level due to its voluntary nature. As per WHO, an average consumption of salt in India is 10.98 gms/day which is more than double the required amount of consumption (5 gms/day). Overconsumption of salt has its own health hazards. Despite being consumed universally on daily basis, there are many limitations in using salt as a fortifying vehicle for many minerals and vitamins such as folic acid, vitamin A and vitamin B due to its chemical properties and less amount of recommended quantity of consumption.

India is leading the world in milk production and it is also a major producer of edible oil crops. Milk and oil are suitable for fortification with micronutrients that are fat soluble such as vitamin A, D, E and K. In India, per person per day calorie supply from milk and oil is 129 and 207 calories respectively (*FAOSTAT*, 2013). It comprises only about 5.3 and 8.6 percentage of total calorific requirements as per the Indian Council of Medical Research (ICMR) recommendations for per-person per-day calorie norms of 2400 kcal for rural areas and 2100 kcal for urban areas. Fortification of milk and oil is the part of an integrated fortification program of India. Milk cooperatives like AMUL and oil manufacturing companies like Adani Wilmar are involved in fortifying most of their brands for Indian consumer market. Despite these efforts, reach of branded fortified goods is limited as consumption of unbranded and locally produced milk and oil is still prevalent in many rural and urban parts of India.

India is among the top two producers of rice and wheat in the world. In 2017, India produced 168 and 98 million tons of rice and wheat respectively (FAO, 2018). Consumption of rice and wheat provides 1206 calories per person per day (FAOSTAT, 2013). These cereals fulfill about half of the total calories required daily for a person as per the ICMR recommendations. Both vehicles are suitable for fortification with many essential vitamins and minerals such as iron, folic acid, zinc, vitamin A, B1, B2, B6 and B12. Shelf life of fortified wheat and rice flour is more as compared to other food products like milk, oil and sugar. Besides being a cheaper commodity, cost of fortifying one kilogram of flour comes to 6 to 10 *paise* (one fifth of one US cent) making it more cost efficient as compared to other vehicles for fortification.

Fortification of whole grain cereals like rice can be possible with production of simulated rice shaped premix. It is important as rice grains are washed before cooking in many countries including India, traditional fortification methods like mixing powder form of micronutrients or external coating methods practiced in North America cannot be suitable. Color and sensory acceptability test for micronized ferric pyrophosphate showed that the fortified rice kernels produced using this premix closely resembled unfortified rice, showed less than 3% iron losses during rinsing and achieved a consistent texture after cooking (Moretti, Lee, Zimmermann, Nuessli, & Hurrell, 2005) making it a better choice for fortifying rice.

Issue with centralized flour fortification

Though being consumed as a staple food in India, rice and wheat consumption is not consistent in the whole country. Wheat is the staple food for most Indians in the wheat growing areas (North, West and Central India) while rice is a staple food in central, south and eastern part of India. In some western and southern parts of India, rice flour is being consumed more in the form of flatbread instead of cooking whole grains. In most of the rural parts of India, people produce their own staple food instead of purchasing it from the market. Similarly, significant number of urban populations prefer purchasing wheat and rice from nearby markets instead of purchasing readymade flour/*atta*. Wheat and rice milling are commonly done at local level using traditional hand milling process or *chakkis*. The share of unorganized flour mills which includes small *chakkis* is 86 percent (Mannar, 2003). Less demand for branded fortified *atta* makes centralized fortification processing of grains a less workable option.

A decentralized small scale *chakki* fortification program was tried in Sundernagar district of Gujarat. Small sachets containing 1.5 g of premix (with 30mg of iron and 150 µg of folic acid per kg of flour) have been produced with instructions of adding and mixing the premix to 10 kg of flour. This experiment helped Gujarat government in scaling up the program in its public welfare schemes like PDS and ICDS and overcoming the initial hesitation and convincing the industry partners including roller flour millers, organized *chakki* operators and small *chakki* owners for fortifying flour.

CHAPTER 5

INTEGRATED APPROACH FOR FLOUR FORTIFICATION

An effective and sustainable fortification program can be operationalized if the public sector (which has the mandate and responsibility to improve the health of the population), the private sector (which has the experience and expertise in food production and marketing), and the social sector (which has grass-roots contact with the consumer) team up to design, produce and promote micronutrient fortified foods (Mannar, 2003).

The key players include the Governments; Research and academic institutions; Food and premix manufacturing companies; Consumer organizations; Development assistance agencies; NGOs, and Media. This synergy not only can help in multiplying the impact of the fortification program but also can help in sustenance of it. Food fortification helps the public sector in reducing malnutrition and in maintaining economic growth. National governments contribute by providing administrative support and proposing the framework for better implementation. The involvement of private industry can help in creating and meeting the demand. Improved product quality through fortification induces demand for regional products and increases trade. An aware consumer demands the product leading to mobilizing industry to respond. International agencies provide technical, funding and advocacy support for development of intervention strategies.

Community-based fortification programs

Community-based fortification plays an important role where decentralized approach for fortification is required due to localized production of staple food. It is beneficial as it encourages ownership of the program in the village community and demystify the fortification process to locals, while ensuring that the fortified food is consumed by the targeted population. Active involvement of all key community members like local health and nutrition volunteers/workers, local administrative body members and other partner organizations helps in awareness generation and monitoring of the program.

CHAPTER 6

SUSTAINABLE FLOUR FORTIFICATION INITIATIVE (SFURTI)

Background

The **S**ustainable **F**lo**u**r Fo**rt**ification **I**nitiative (SFurtI) was launched in 15 tribal villages of Songadh block in Tapi district of Gujarat in June 2016. SFurtI is an example of community-based flour fortification program. Gujarat is an Indian state experiencing rapid economic growth, also finds itself performing badly on nutrition indicators and micronutrient adequacy. SFurtI was launched to reduce the micronutrient malnutrition by providing easy to use home-based food fortification method.

SFurtI is a multi-partner nutrition initiative. It is being implemented by Tata-Cornell Institute for Agriculture and Nutrition (TCI) along with the consortium partners including BAIF Development Research Foundation (BAIF), Sight and Life, Tata Institute of Social Sciences (TISS), Maharaja Sayajirao University (MSU), and Shri Surabhi Swasahay Federation. BAIF has been working in several villages in the program location and had facilitated setting up of the Shri Surabhi Swasahay Federation, an apex-level body of almost 65 self-help groups (SHGs) covering approximately 555 households from these villages. Sight and Life, a CSR organization of DSM micronutrients Ltd., is supplying micronutrient sachets to the Women's federation. TISS is providing the logistical support for the program under the supervision of TCI while MSU is involved in the program for clinical and nutritional evaluation. Shri Surabhi Swasahay Federation is acting as an implementing agency involving its women Self Help Groups (SHGs) members for the communication and distribution of the fortificant. A Theory of Logic (TOL) model (See figure 1) explains the contexts

and goals of the SFurtI program, links the resources and activities to the outputs, and identifies the basic assumptions of the rationale.

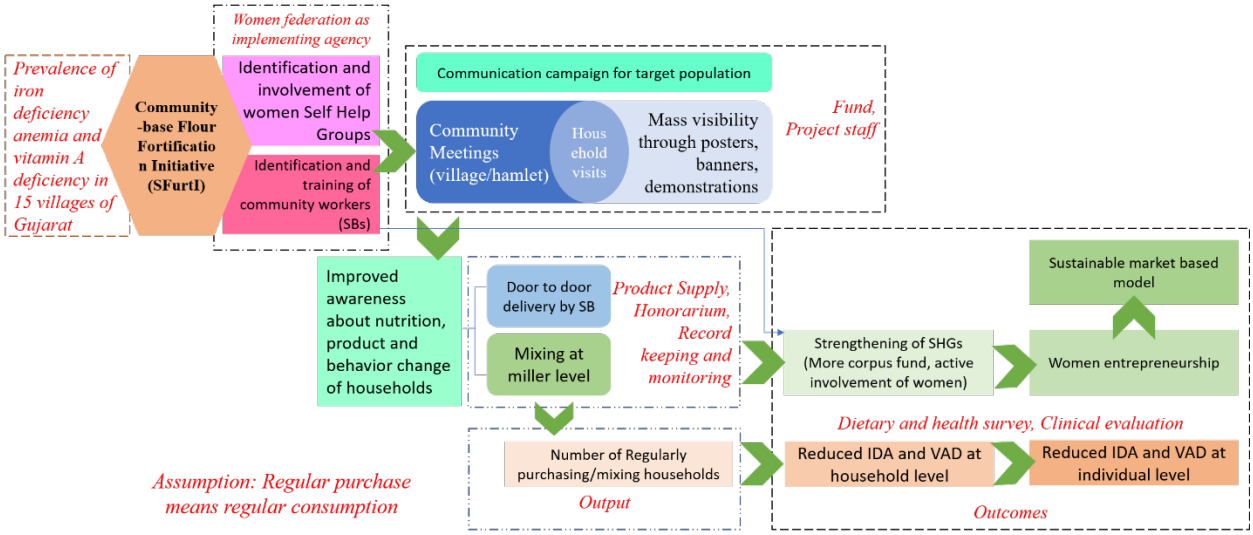

Figure 2: SfurtI: Theory of Change model

Sight and Life Foundation has developed Sfurti, a fortificant powder composed of iron, folic acid, vitamin B12 and vitamin A in appropriate quantities which when added to flour of a proportional quantity, can provide the consumers with a satisfactory level of access to the respective micronutrients. The powder is packed in the form of a small sachet which doesn't have any specific storage requirements with regards to temperature and hence can be easily transported. (See Figure 2).

Figure 3: Sfurti fortificant with its contents

Sfurti sachet contains 1.25 grams of the powder which when added to 5 kg of flour suffices for the bodily needs of the respective micronutrients. In addition to being handy in terms of storage, special attention was paid so that the powder was tasteless, colorless and odorless. The colorless property is particularly important since iron fortificants in the past have known to add a blackish color (due to ferrous sulphate) to the food making the food look ugly and hence, less likely to be consumed. Also, given the variety of grains which people consume, the powder was developed in a manner that it could be added to any type of flour and the results would stay the same.

Since, the powder is in a small quantity and is mixed to a relatively large quantity of flour, the process to mix must ensure homogenous distribution and hence, is slightly complicated. It could be mixed both at home and at a miller. For home-based mixing, 5 kg of flour must be first roughly equally split into three bins. Thereafter, the entire contents of the sachet (1.25 grams) must be added to one of the bins and be thoroughly mixed in the flour for about 30 seconds. This mixed flour should then be added to either of the other two bins and again mixed in the same way and

eventually be added to the third bin and mixed for another 30 seconds. To mix at a miller, the powder was to be added to the grain before getting milled.

Program implementation

The program was implemented in 15 similar villages in Songadh block of Tapi district in Gujarat. All villages have a majority tribal population involved in agriculture and dairy activities. TCI partnered with BAIF to facilitate the distribution of the Sfurti powder (hereafter referred as Sfurti). Under the program, TCI recruited and trained 28 women from the BAIF run local women self-help groups. These women were named Sfurti Ben (translates to Sfurti sisters). Since, the approach was to make people voluntary adopt in the program, instead of making it available to all for free, a price was fixed for Sfurti sachets. The price, Rs. 3 per sachet, was decided mutually by the residents of the target villages through focus group discussions organized by the self-help groups. A few Sfurti Ben were recruited from each of the 15 target villages based on the population and size of the village. Each Sfurti Ben was then assigned a few hamlets in her own village and was trained to go door to door to all households in her assigned hamlets, to sell Sfurti. Additionally, their job was to help increase awareness about Sfurti, and iron in general within the households that she would visit. An implementation plan of SFurtI is described in the figure 3.

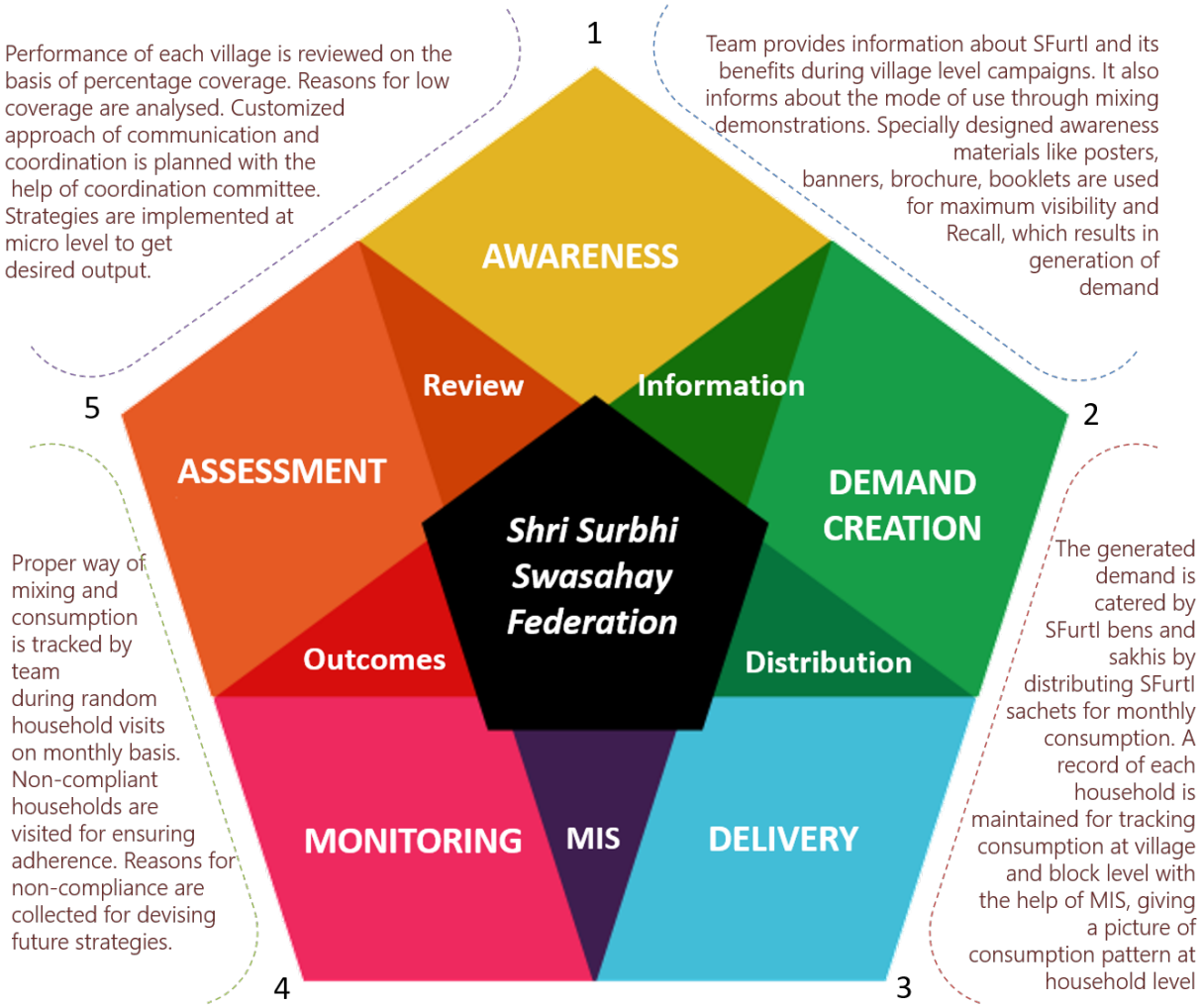

Figure 4: An implementation plan of SFurtI

Involvement of women in the distribution of the sachets makes it easier to communicate and counsel about the nutrition deficiency and use of Sfurti to the women members of the households who are responsible for preparing meals. All 28 Sfurti bens cater to about 5600 tribal households in 15 villages. They get an incentive of 50 paise per sachet sold from Shri Surabhi Swasahay Federation besides a fixed monthly honorarium of Rs. 1000 each from TCI.

Given the nature of delivery, through women within the village, the program was centralized in planning but decentralized to the villages in implementation. In addition to Sfurti Ben, other local

institutions such as dairy cooperatives (highly popular in this particular region of India), ASHA workers (government trained nurses who go door to door to provide basic checkups and render vaccinations), Anganwadi workers (child care providers), schools, churches (high proportion of the target population are Christians) etc. were roped in to increase awareness (See Figure # for a representation of the various institutions used). However, sales were made only door to door through Sfurti Ben.

Figure 5: Involvement of different community groups under SFurtI program

The program was officially launched in June 2016 in all the 15 target villages simultaneously. The program had two phases of implementation. The first phase was launched in June 2016 and entailed Sfurti Ben going door to door to sell the Sfurti sachets. This phase after running for 10 months culminated in March 2017. The second phase was launched after a 5-month gap in September 2017 with a minor change. In the second phase, 5 villages were selected, where the sales were not made

through the Sfurti Ben, but were made at the miller level. An attempt was made in the second phase to test if people after having been exposed to the first phase, would now be willing to buy the Sfurti sachets by themselves through the miller. Under this attempt, 32 local millers were roped in into the program as Sfurti millers. Sfurti Bens in these 5 villages were still involved in awareness generation activities but would not sell Sfurti sachets to any households. For the remaining 10 villages, the implementation was identical to the first phase.

CHAPTER 7

SFURTI THROUGH THE LENS OF MULTIDIMENSIONAL FRAMEWORK FOR NUTRITION

A nutrition sensitive food system requires a fine blend of nutrition specific interventions and strong policy oriented complimentary approaches for infrastructure investment and producer incentives. The challenge is to ensure enough quantity of balanced diet which is accessible to all the people to all the times. In India, it is more difficult to ensure diet diversity. It is because of poor supply chain mechanism leading to perishability and limited access, high prices making it not so affordable for low income price sensitive households to have more diversity in diet, personal and religious food choices, and existing single crop system discouraging diverse production. These challenges cannot be addressed by the single approach. A multidimensional approach involving agriculture, education, infrastructure investment focused on better health and nutrition outcomes is required. UNICEF (2013) has developed a framework that looks at the linkages between the food economy at the macrolevel, household level and the individual level. Other researchers proposed their versions of frameworks, differing in their focus on specific factors. One such framework is discussed in detail in (P. L. Pingali & Ricketts, 2014) and is presented in figure 5 The drivers of nutrition change are explained by the framework in terms of four quadrants (Pingali & Ricketts 2014). The first pathway is described through the income mechanism (quadrant 1), where gains in household income lead to increased access to diverse food resulting in the availability of a diverse set of micronutrients for consumption. It is well established that nutrition outcomes are directly impacted by eating habits and other behaviors, including those that may be

considered as non-nutrition related (e.g., those involving sanitation and hand-washing). The second pathway explores all the behavioral traits that impact nutrition (quadrant 2).

Quadrant 3 discusses about the factors impacting intrahousehold food distribution. These factors are important in determining the individual-level food access within the household, especially about women's and girls' access to food, both in terms of quantity and diversity. Women's empowerment enables them to ensure an equitable food distribution for themselves as well as their children. Lastly, quadrant 4 looks at improving the ability of the people to translate food intake into absorbed nutrients, and thereby positive nutrition outcomes, through enhanced environmental factors, such as access to clean drinking water and sanitation.

The framework divides four factors into two main columns: household-level factors and individual-level factors. Quadrants 1 and 2 consist of the household-level factors that affect the quantity and quality of diets. Concurrently, quadrants 3 and 4 comprise the factors that affect intrahousehold equity in food consumed and the nutritional impact at an individual level.

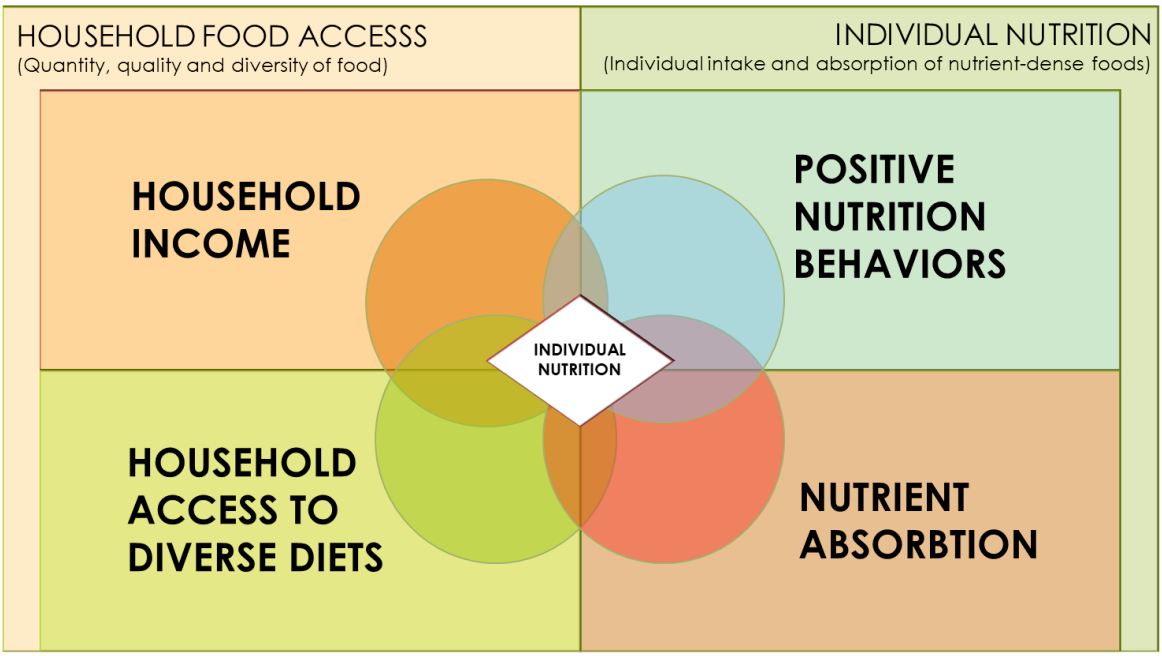

Figure 6: Multisectoral pathways toward improved individual nutrition. Adapted with permission from Pingali & Ricketts (2014)

SFurtI, as a community-based fortification program can be explained through this mulitidimensional framework for nutrition. SFurtI serves as a reasonable option for a low income, nutrition deficient population which cannot afford to have a balanced diet on regular basis. It supports a household in achieving the required amount of nutrition where the scope of diet diversification is limited due to various reasons. The program also supports the positive nutrition behavior through its broader communication campaign which revolves around the involvement of fortified flour in the diet, the importance of nutrition rich foods, proper water and sanitation practices, and balanced diet. The role of SFurtI in achieving better nutrition outcomes for each quadrant of the framework is explained in details as follows.

Household income

Household income has a direct impact on the household food security. Household income determines by various livelihood activities. In the SFurtI target villages, majority of the people are involved in subsistant agricultural activities. The low agricultural income can be a result of many factors such as low agricultural productivity, low wages for agricultural labors, effect of seasonality on food production, relative prices and price policies. Age, gender and education is also playing an important role in deciding the household income. Tribal communities in the target villages do migrate in nearby towns as agricultural labor. More number of available manforce reduces the wages and compramises the living standards. Women and children are actively involved in the agricultural activities but are getting less wages compared to men. Subsistant farmers hardly manage to produce enough food for their family keeping them dependant on the social security schemes of the government. Low income makes them more price sensitive which reflects into monotonouse diet with limited amount of calories and nutrition.

SFurtI is providing a cost effective option of improving the nutrition intake without compromising current dietary habits. The prevalence of micronutrient deficiency due to not having balanced diet has been compensated through the home-based fortification method of the program. The price of Sfurti sachet, Rs 3, was decided by the community members. It can be easily afforded by the most of the target population. Unlike the existing government health schemes which are mostly focused on the women and children, SFurtI is reaching to all the family members providing them sufficient amount of four essential micronutrients on daily basis.

Household access to diverse food all year

Balanced diet can be achieved through dietary diversification. It is the best way of insuring better nutrition. Dietary diversification is determined by the proximity of the household from diverse food market, agricultural diversification and livestock, extent and type of the agricultural commercialization, gevernment interventions and safety net programs. Many rural areas of India are not well connected to the retail markets at block and district level. Most of the rural population depends on the local weekly markets for their food supply. Poor and limited supply of diverse food stocks makes it difficult for rural consumers to buy it at affordable prices. Besides perishable items, these markets serve unbranded ready to eat food, snacks, and confectionaries. These items don't follow the strick FSSAI guidelines and can be sold post expiry dates. Due to poor knowledge about the labelling and nutrition, rural population many times end up making bad food choices. Subsistant nature of farming limits the scope of commercialization of agriculture (P. L. Pingali & Rosegrant, 1995). All the agricultural activities are mostly done by the family members. It results into no/limited diversification in agricultural production and heance consumption. The safety net programs like PDS are more focused towards the calorific diet and pay hardly any attention towards nutrition. Most of the PDS programs supply fixed quantities of rice and wheat on the name of food security. Nutrition interventions through ICDS are only focus towards priority goups of women and children for limited period of time.

A diet assessment survey of 200 households was done by TCI in Dec 2015 before the launch of SFurtI. It shows that almost all the households cannot afford having diverse diet on a regular basis. A monotonous diet patterns were observed including daal-rice/khichdi for lunch and seasonal vegetable and rice bread for dinner. Though milk is being collected from all the villages by the

dairy cooperatives, consumption of milk is very less in all age groups. The data reveals the poor intake of iron and vitamin A rich diet among the target population (See table 3). The frequency of consumption of the listed iron and vitamin A rich food may not be sufficient for majority of the households to provide the required amount of iron and vitamin A on daily basis. RDA for vitamin A is 600mg for an average adult person while the RDA for iron is 17 mg/day and 21mg/day for an average adult male and female (*NIN*, 2011). Low frequency of consumption of following food items can be attributed to the poor access and affordability.

Table 3: Food frequency data of situation assessment survey

Sl #	Name of food	Percentage of HH level frequency									
		Daily	5-6 times/ week	2-4 times/ week	once/week	once in 8-10 days	once in 11-15 days	once a month	occasionally	seasonally	never
A	**IRON RICH FOODS**										
1	Colocasia leaves	0	2.1	3.1	3.6	0	2.1	25.5	37.0	.5	26.0
2	Soyabean	0	1.6	7.3	5.2	2.1	6.3	14.6	28.6	0	34.4
3	Niger seeds	0		.5	0	0	0	0	.5	1	97.9
4	Cauliflower leaves	0	5.7	12.5	12.0	4.2	7.8	9.9	19.8	.5	27.6
5	Cow pea leaves	0	0	.5	.5	0	0	0	.5	1.6	96.9
6	Garden cress leaves	0	.5	3.6	0	.5	1.6	4.2	18.8	37.0	33.9
7	Mustard leaves	0	.5	0	0	0	0	0	1.0	.5	97.9
8	Radish leaves	0	0	3.6	3.1	1.0	.5	11.5	25.0	8.3	46.9
9	Shepu	0	0	1.0	0	0	1.0	11.5	8.9	1.6	76.0
10	Turnip leaves	0	.5	0	0	0	0	0	0	1.0	98.4
11	Lotus stem	0	0	0	0	0	0	0	.5	0	99.5
12	Garden cress seeds	0	0	0	0	.5	0	0	4.7	.5	94.3
13	Bombay duck fish	.5	2.1	9.9	7.3	1.0	5.2	18.8	18.8	.5	35.9
14	Crab	0	0	0	2.1	0	.5	2.6	19.8	27.1	47.9
15	Beef	0	0	0	.5	0	0	1.0	0	0	98.4
16	Amaranth spinosis	.5	3.1	7.3	6.8	4.2	1.6	2.1	7.3	64.1	3.1
B	**VITAMIN A RICH FOODS**										
17	Sweet potato		.5	5.7	1.6	.5	0	9.4	55.7	8.9	17.7
18	Carrot	1.0	4.2	12.5	5.7	2.1	7.3	15.6	32.3	14.6	4.7
19	Pumpkin	0	0	.5	.5	0	.5	.5	2.1	86.5	9.4
20	Spinach	0	3.1	9.9	5.7	3.6	16.1	10.9	9.9	25.0	15.6

21	Papaya, ripe	0	0	1.0	.5	0	0	3.1	56.8	27.6	10.9
22	Mango, ripe	0	0	0	0	0	0	0	2.6	96.4	1.0
23	Lettuce	0	0	0	0	0	0	5.2	8.3	1.0	85.4
24	Fenugreek leaves	1.0	5.7	27.6	6.3	3.1	14.6	10.9	5.2	25.0	.5
25	Colocasia leaves, Green	0	1.6	2.6	2.1	0	2.1	18.8	45.8	0	27.1
26	Drumstick leaves	0	0	0	0	0	0	0	1.0	2.1	96.9
27	Egg, duck	0	0	0	0	0	0	0	1.0	1.0	97.9
28	Egg, hen	0	3.6	17.2	16.7	2.6	18.8	13.0	8.9	.5	18.8
29	Liver, sheep	0	0	0	0	0	0	0	0	0	100
30	Gogu	0	1.0	5.2	.5	.5	2.1	4.2	22.4	57.3	6.8
31	Ambat chuka	0	0	0	0	0	0	0	2.1	25.0	72.9

The factors discussed above can curtail the scope of diversification of the diet at household level through out the year. SFurtI can be successful in filling the gap created by the poor dietary diversification through its home-based fortification. It's affordable, easy to use fortification method ensures adherence and supply of four essential micronutrients on daily basis. Though rice is the staple food of most of the tribals of the target villages, the fortificant which can be mixed with any type of flour, provides a broad range of options for vehicles in which SFurtI can be mixed. It ensures the intake of prescribed amount of micronutrients on daily basis by most of the family members in the households.

Positive nutrition behavior

Intra household equity in food access is an important factor in determining positive nutrition behavior. The question about purchase, preservation and preparation of micronutrient-rich foods and its intra household allocation determines the individual nutrition intake. Cultural stimas around the food processing and consumption are the major barriers in achieving full benefits of nutrient-rich foods. Less consumption of green leafy vegetables, excess use of spices, overconsumption of oxalate and phytate rich diets, overcooking of food are some of the common cultural practices in

India which hinder nutrition absorption. Religious choice of vegetarian diet, fasting, not allowing to consume white color food items like rice, milk, eggs to pregnant and lactating mothers[2], denying vaccination and supplementation to children of age under 5, etc. are also some of the prominent health depriving religious practices observed by many communities in India. For example, vitamin B12 Deficiency is widespread in Indian Population majorly due to absence of non-vegetarian diet. Prevalence of vitamin B12 deficiency is found out to be 47% in north India (Singla et al., 2019). The status of the other parts of India is believed to be not anything different. Lack of vitamin B12 can have adverse physical and neurological effects on the body. And sometimes can be fatal.

The prevalent gender norms in a patriarchal society can affect the nutrition outcomes for an individual. In rural India, women are equally responsible for income generating activities but they have limited say over the decision regarding spending the money they earn. For example, if a crop is grown and kept, the woman likely makes decisions about when and how it will be prepared. If it is sold, husband likely controls how that money is spent. There is no gender equity in distribution of household assets which sometimes includes food. The work is loosely defined as an income generating activity which doesn't count the income saving activities like household corus, child care, etc. Women are supposed to be responsible for these activities along with other income generating activities mostly related to agriculture. It means more work for women. It creates a significant gap between the food intake and daily calorific and nutritional requirements of their bodies. This can be due to giving preferantial treatment to male members of the family when it comes to intrahousehold food allocation. Though women can take the decision regarding what to cook, they have to keep in mind the personal likes and dislikes of their male family members.

[2] It is the practice still followed by Kotwaliya tribal community members in South Gujarat.

Though keeping fast is a matter of religious belief, there is also a social/peer pressure (mostly from in-laws, husbunds, neighbours, and other close relatives) on women for observing it. Sometimes it ends up in starvation resulting in to poor nutritional health.

Nutrition status of men is not well either. As per the NHFS 4[3] data, more than 20% of Indian men are malnourished. It affects their personal and social life negetively. Addiction of alcohol, tobbacco and other related products causes further damage. It creates economic burden on family due to less working hours and more expenditure on addiction by earning male members. It forces a household to reduce the expenditure on the food items. It leads to reduction in number of meals which makes the household members more food insecure.

Involving women members of the household with the discussion around the positive nutrition practices can be benefical in two ways. First, it will help in overall improvement in nutritional intake of the family members. Second, it will involve women members in the household not only as a change maker but also as primery beneficiaries.

Collective efforts should be made for involving women in the discussion regarding positive nutrition behavior. About 2.2 million self help groups (SHGs) are currently operating in India (NABARD, 2018). Most of them belong to women. SHGs are proving to be a good medium of consolidating and educating women regarding many issues along with the traditional objective of providing financial assistance for livelihood activities. Many public welfare programs in India are involving women SHGs for their implementations. For example, ICDS centers in many states are

[3] National Family Health Survey round IV (2015-16)

running their nutrition supplementation program through women SHGs, where these SHG members are responsible for purchasing, processing and cooking of meals for kids and pregnant and lactating mothers in ICDS centers.

SFurtI is also being implemented through the federation of women SHGs. Under the program, the women SHG members are responsible for communication, networking and distribution of fortificant at household level in all target villages. Women can prove to be a better channel for implementing home-based fortification programs in India as they are the ones who are usually responsible for processing and cooking of the food for all household members. Women SHGs can serve as a medium to organize women. This plateform can be useful in carrying out the discussion about the program during their regular group meetings with other members. Involvement of women helps in sustaining the program for achieving desired results.

Many communication activities under the SFurtI program like nutrition workshops[4], mixing and cooking demonstrations[5] of fortified foods involve women and aware them about the positive nutrition behavior. The regular demonstrations improved the recollection and helped in changing individual's behavior towards nutrition. Involvement of women SHGs in the program also improved the bargaining power, nutrition awareness/education and decision making power of women and positively benefited the overall nutritional status of the other household members.

[4] Informal sessions of women focusing on the importance of nutritional food through audio video presentations

[5] Demonstrations to women members for mixing Sfurti powder into the flour and cooking flat breads from this Sfurti flour.

The purchase data of the program shows more than 80% households of SHG members purchased Sfurti regularly[6] as compared to the 41% of regular purchases made by the non-SHG members in all 15 target villages during the second phase of the program. The household level survey by TCI also reflects the influence of women group membership on the decision about the purchase of Sfurti sachets is prominent among other variables (See table 2). While being a member of the dairy cooperatives increases likelihood of purchase by about 4% across phases, being a member of the BAIF SHGs increases likelihood by 5% in the first phase, whereas by 11% in the second phase (*Gupta, 2018*).

Table 4: Selected coefficients when regressing monthly purchase decision on household variables

Variable	Phase – 1	Phase – 2	Combined
Christian	0 (0.01)	0.01 (0.02)	0 (0.01)
Cult. Land	0 (0)	0 (0)	0 (0)
Sugarcane cultivator	0 (0.02)	0 (0.03)	0 (0.02)
Dairy	0.01* (0)	0.01 (0.01)	0.01** (0)
Children < 5	0.04*** (0.02)	0.04* (0.02)	0.04*** (0.01)
Dairy coop member	0.03* (0.02)	0.04* (0.02)	0.04** (0.01)
BAIF SHG member	0.05** (0.02)	0.11*** (0.03)	0.07*** (0.02)
Other group member	0.03* (0.02)	0.02 (0.02)	0.02* (0.01)
Iron awareness	0.01 (0.02)	0.05** (0.02)	0.03* (0.01)
Time from launch (in months)	0.02 (0.01)	-0.11*** (0.02)	0 (0)
Time from launch (in months) sq.	0 (0)	0.01*** (0)	0 (0)
Purchased last month	0.26*** (0.02)	0.36*** (0.02)	0.33*** (0.01)
Purchased two months before	0.17*** (0.02)	0.21*** (0.02)	0.19*** (0.01)

***p<0.01 **p<0.05 *p<0.10; Controlled for village fixed effects and sub-caste fixed effects;

[6] SFurtI MIS has defined regular purchase as repeat buying of Sfurti sachets for 5 or more months.

SFurtI has effectively utilized the power of women SHGs for changing the perception of people towards their nutritional needs. Involvement of women SHGs helped the program in behavior change communication with regards to nutrition. Existing food habits which are going on since the birth of an individual cannot be easy to alter. Cultural and religious aspect of food habits has an emotional angle attached to it and can be difficult to change. SFurtI through it's communication activities, involved few messages to change some of the prevalent practices which can have a positive impact on nutrition behavior. For example, through it's communication campaign, SFurtI talked about avoiding overcooking, covering the food while cooking, not having tea or coffee immidiate after or before meals, inclusion of fruits, green leafy vegetables, milk and milk products in the diet along with having rotis made from Sfurti fortified flour. These messages were delivered by the women SHG members who are the part of the community and have a better social credibility. Repeated communication along with regular demonstrations might have a positive impact on the nutrition behavior. An increasing trend in the sale of fortificant shown by the purchase data (See chart 1) can be attributed to the changes in nutrition behavior as an effect of strong communication compaign. Unfortunately, there is no data available to quantify the impact of these messages.

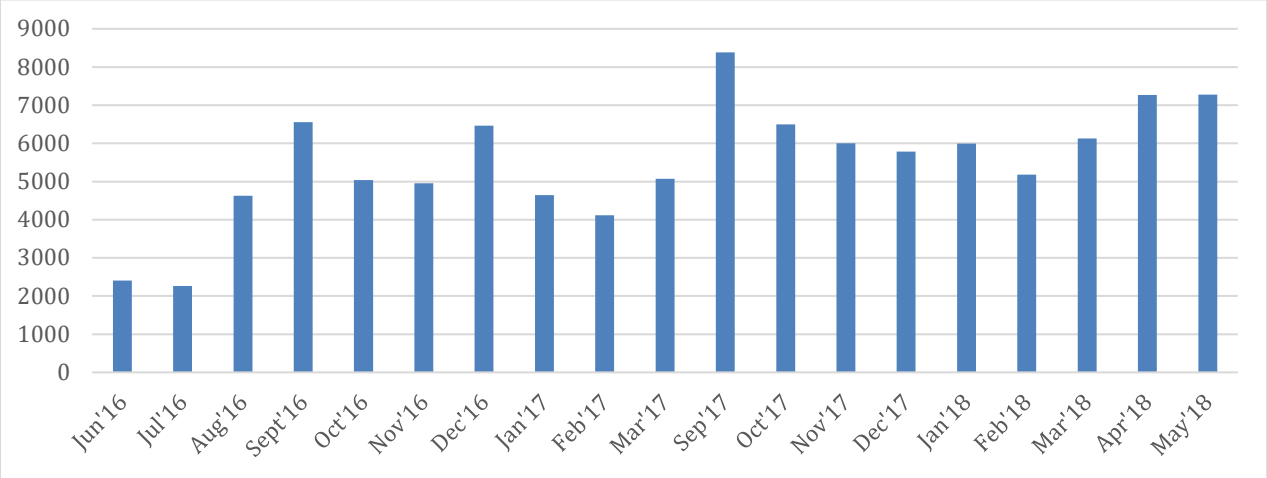

Chart 1: Monthwise purchase of Sfurti sachets

Nutrient absorption

Nutrient absorption is a process of absorbing macro and micronutrients into body cells. This process needs to be well-functioned in order to achieve a better health. There are many factors that can affect the process of nutrient absorption. Water associated vector borne illnesses, zoonotic diseases[7], contamination of food and water, and malnutrition can have a negetive impact on individual level of nutrient absorbtion. Not having a diverced diet and bad food habits can aggrivate the condition. A WHO data shows that almost fifty per cent of the developing world's population which is around 2.5 billion people lack improved sanitation facilities[8], and over 884 million people still use unsafe drinking water sources.

A simple approach of providing a home-based fortification through SFurtI program has taken care of nutrient absorption component upto some extent, though not exclusively. Unlike other community-based programs which use ferrous sulfate ($FeSO_4$) for providing elemental iron, SFurtI has used sodium iron EDTA (NaFeEDTA). NaFeEDTA is a most suitable iron compound for flour fortification due to its more relative bioavailability (RBV) than $FeSO_4$ (Kurpad, 2012). $FeSO_4$ has a RBV value upto 100 whereas NaFeEDTA has it in between 100-390 (Kurpad, 2012). It makes Sfurti a better quality fortificant with high level of nutrient absoption.

Communication campaign of SFurtI also focused on providing awareness regarding better nutrient absorption habits. Repeated messages like eating variety of food in one meal, pairing vitamin C rich food like lemon (easily available) while having Sfurti fortified roti, consuming yogurt,

[7] A disease that normally exists in animals but that can infect humans.
[8] A sanitation facility in the form of connection to a public sewer, septic system, pour-flush latrine, simple pit latrine or a ventilated improved pit latrine

avoiding tea, coffee immidiate before or after meals, etc. helped in sensitizing population about the importance of nutrient absorption. Besides these, SHG women used to talk about proper sanitation and clean drinking water practices in village level meetings through presentation and audio visual media. This helped in motivating people for applying for government aided household toilet scheme which resulted into the increase in the percentage of toilets from 50% to 75% within two years of the implementation of the program. The repeatative messages and improved water and sanitation practices might have a positive effect on the individual nutrition absorption.

CHAPTER 8

CONCLUSION

Micronutrient deficiency is a global health issue affecting millions of people worldwide. Its multifaceted effects can hamper an individual's mental and physical development leading to a less productive society. Food fortification is a feasible and cost effective method to reduce the micronutrient deficiencies, alongwith other approaches like balanced diet, supplementation, public health measures like immunization, deworming, safe water and sanitation. The food fortification experience gained in developed countries as well as developing countries effectively demonstrates that it is possible to select an appropriate fortification intervention based on the target population and suitable food vehicle. Partnership approach to end 'hidden hunger' between the governments, social sector organizations, private sector, academicians, civil societies and most importantly the consumers need to play an important role in generating demand and meeting the supply of fortified food to combat micronutrient deficiencies effectively.

The community-based fortification programs like SFurtI are important for promoting the need of decentralized approaches for better community nutrition. An active participation of women SHG members in implementing the program can pave a way for integrated approach to achieve better health and nutrition services for priority households with the support from women SHGs and other community institutions like cooperatives, schools and local administration. Involvement of village level agencies can develop the sense of ownership among the partners and can sustain the program for achieving desired results. SFurtI has effectively used an existing network of women as a delivery mechanism and empowered it by providing the federation a livelihood activity. It

successfully created a line of village level women entrepreneurs who can provide nutrition services at the doorstep of the beneficiaries. Increasing percentage of the consistent Sfurti fortificant consuming households can be linked to the increase in the awareness regarding better nutritional health.

A multidimensional framework for nutrition proposed by UNICEF can be very well explained through SFurtI. It establishes itself as a promising initiative which can effectively support in meeting the gap between the household food access and individual nutrition through its home-based fortification method. It provides the enough quantities of four vital micronutrients to the low income priority households which otherwise would not have been possible due to limited access to diverse food. It's innovative and inclusive communication campaign can be associated with the positive change in individual nutrition behavior and nutrient absorption.

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